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ABSTRACT

A 1993 study compared trends in the structure of qualifications for occupations related to the installation, management, and maintenance of computer networks in Germany, France, Italy, the Netherlands, Portugal, and the United Kingdom. Staff involved in networks required specialized new skills related to feasibility and design, installation, management, help for users and assistance, and monitoring and maintenance. Initial training was essential only when staff had not participated in setting up and installing the network. Specific, supplementary, continuing training almost always followed. The very diversified and changing nature of techniques related to computer networks made informal experience particularly important. Differences in the recognition of qualifications probably related to such factors as the certification and the degree of sophistication of the certification system. The tasks identified in the six countries were generally the same although the scope of such activities varied. In all countries, there was a more or less formal recognition of the tasks of network manager and network maintenance. Three conclusions were reached: the computer network sector was one of the most dynamic in the European economy; interfaces and high quality specialists were needed; and there was a gap between company needs and skills taught by training organizations. (YLB)

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Trends in the structure of qualifications for occupations relating to computer networks

This paper examines a study carried out in 1993 as part of CEDEFOP's activities to obtain comparative studies on qualification structures in various national contexts. The study which was carried out in Germany, France, Italy, the Netherlands, Portugal and the United Kingdom compared trends in the structure of qualifications for occupations relating to the installation, management and maintenance of local and wide area networks (see following). In Spain, Denmark and in French-speaking Belgium, partners were asked to compare initial findings to the situation in their own countries.

Differences exist which are attributable to the investigation methods used, to the non-exhaustive nature of the investigation, to the features of the companies examined and their networks, to the national context and to interpersonal relationships with those interviewed, their status in the company, the degree to which they were prepared for the study and the interview conditions.

On the long term, the issue is one of responding to the need to develop human resources capable of reacting to social and economic changes and, more particularly, to changes in work organization and job profiles.

* The networks

During the past thirty years we have witnessed the development of high capacity transmission systems and more recently over the last ten years increased use of personal computers and microcomputers.

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At that time, plans were forged to optimize utilization of minicomputers by creating computer networks and allowing users who are geographically dispersed to make common use of software and computer services.

Connecting different computer equipment culminated in an architecture called "network", either local or distant depending on whether this be a small or large geographical area: a building, a campus... High transmission speeds and low error rates are the characteristics of such networks. The network has two main functions: to transport data and to process data required by the company and individuals. Situations vary depending on the complexity of the networks, the size of the companies, the way in which they are organized, the type of activity, and the existence of one or several places of activity or production, the importance and the age of the network(s), the importance of contacts to the external world and the national context.

On account of and parallel to simplification of their installation, networks have increased in number. A distinction can be made between large networks in large companies which are often industrial and where there are marked specializations and smaller networks (word processing, exchange of data...) which is usually the case in SMEs or in other companies not facing complex operations.

There is a need to adapt staff to these jobs and to increase the number of staff to develop the network and to ensure user training.

* The specific tasks of networks

Staff involved in networks require specialized new skills in relation to the following tasks:

- Feasibility and design

Feasibility is the phase for designing the processing and circulation of information and for setting up the network, developing and optimising this, making use of existing computer and telecommunications resources in line with corporate strategy.

The planning stage involves preparing and designing an architecture. Practical means of installing the network must be listed in terms of human and material resources, future trends, time, cost, geographical location, processing and circulation of data. The main issues to be studied involve organization and aims.

- Installation

Based on a diagram of the network and paying due regard to security matters and possible extension, installation involves the physical setting up of equipment, the organization of work posts, access of the various users to the hardware, writing configurations, protocols, verifying the operability of the system through tests, monitoring implementation of the options selected by the company and respect for work hygiene.

- Management

Network management aims to ensure optimal running of the system, that is to say, to guarantee quality and continuity of service in transmitting data under normal conditions or in exceptional situations unforeseen at the design stage. It also involves liaising with the users, suppliers and with the staff in charge of installation and maintenance.

- Help for users (help desk) and assistance

This applies to users who encounter all sorts of difficulties relating to the computer or the network. Users must be informed and trained. Problems are listed and registered and resolved in order to ensure subsequent better running of the system in order to complete the tasks in the time and quality required within the existing financial constraints.

- Monitoring and maintenance

A monitoring and maintenance plan must be formulated and implemented to ensure that the system continues to run well, to avoid breakdown, and maintain efficiency of the software. This monitoring encompasses the entire system to reduce down time and to improve overall running.

REMARKS ON TRAINING AND SKILLS: CONSTANT FACTORS

On examining the national conclusions, it would appear that companies seek individuals who have a good capacity to adapt, to establish good working relations with others in order to fulfil tasks successfully.

In addition, there is a a priori distribution of skills over all the posts involved, from the computer department of a large company to the secretary in an SME. Staff with such job profiles who in the past were isolated from the rest of the company are today called upon to participate in corporate decision-making.

Initial training is only essential when staff has not participated in setting up and installing the network, particularly in SMEs which are not specialized in computers. On the other hand, later recruitment to an equivalent post requires advanced basic training. In this sense, one needs to recall that

new technologies raise the quality of competences of individuals who have undergone sufficient initial training. On the other hand, in large companies and in those involved in manufacturing and selling computer equipment and services, demands increase in line with the complexity of the network. Specific network training has increased considerably since this study was initiated. To an increasing extent networks are introduced in training courses on electronics and computer science. Gaps are generally due to the lag between instruction and corporate life. It cannot be said that the education systems are giving a global response to this area of activity.

Initial training is almost without exception followed by **specific, supplementary, continuing, post-initial training.** This is a good response to skill needs. Whether of a one-off nature or periodical, training is required in order to adapt individuals to the work post in terms of technical and social skills. Developing the management aspect for staff involved with the networks and the increasing strategic importance of specialized training has considerable implications.

At the beginning training corresponds to internal company initiative or the services of specialized bodies, the manufacturers and suppliers themselves. The large manufacturers supply training and it would appear that in response to labour market needs there was a great increase in "network" training at the risk of causing such saturation similar to that when computers were introduced in companies on account of new advanced technologies. To avoid an imbalance between company needs and the training offer, staff must be offered training which takes into account the need to adapt to trends and technologies as the risks of redundant knowledge are increasing.

Finally, the very diversified and changing nature of the techniques relating to computer networks makes informal experience particularly important. The level of skills and competences attained due to practical work and specialized training or self-training is raised as only work experience on the job in resolving errors and problems and a curiosity in network operations provides real skills attributable to daily working, an ability to adapt and high motivation.

Practical experience which can be acquired in SSIIs (computer service agencies) is often an entry requirement.

In concrete terms large companies and large companies in the computer sector are making long-term investments and ensuring staff training. The computer service agencies (SSIIs) are seeking highly qualified staff who

may become operational immediately. The SMEs require staff entering immediately into service and they may be self-trained or come from within the company. There are three types of profiles: staff who come up through the company and exercised other trades, staff who have trained in computer technology and where a distinction can be made between SSII staff with specific technical knowledge and versatile staff on the networks generally in small enterprises.

The recognition of qualifications takes on a variety of forms and differences probably related to a variety of factors such as the certification and the degree of sophistication of the certification system. For example, in the employment contract even in the same profession the provisions and certificates may vary from enterprise to enterprise. Recognition may also be part of the collective bargaining agreement. One can see a spontaneous passage, not included in any agreement, from the creation of an occupation to recognition of a qualification. Generally job titles are both vague and varied and do not provide insight into the level and importance of the activities to be undertaken. We are dealing with occupational profiles which are undergoing change. The tasks required of members of staff are changing rapidly. In small companies there is a need to progress from installation and operation of the system to changing the system, making technical modifications and to caring for users' needs. There is little institutionalization of qualifications with the exception of the large companies where activities change less quickly.

TASKS AND MAJOR TRENDS: The emergence of administration and maintenance functions.

The tasks identified in the six countries studied were generally the same although the scope of such activities varied. If it is not possible to define the general aims of these tasks in networks, this is due to the fact that in certain companies this would require five minutes while in others ... 6 months! It is possible to describe certain types of activities relating to certain tasks, but it is evident that the description of the tasks are related to the instruction manuals which must be adhered to in order to operate the networks, which implies that the network itself must be described.

The activities may be classified in a more or less detailed manner, depending on the experience acquired in networks by the bodies studied and the integration of these in the qualifications lists of the institutions in the various countries. In the United Kingdom, the Lead Bodies define the competent standards required by creating a common reference for each specific sector. This culminates in an exhaustive list of activities which is loosely formulated.

A number of tasks are transversal to certain occupational profiles. Providing advice, training, monitoring and extending, developing and up-dating the system require fundamental skills, communication skills, the ability to work along with others, the ability to impart knowledge and capabilities, a sense of responsibility in addition to technical and technological skills. As far as the task of administration is concerned, attention is devoted to the quality in which information is provided and to the broad field of activities encompassed by this task. While in Great Britain it was stated that this task is accessible to a beginner, this is not the case in the Netherlands, where only the tasks of administration can be distinguished as an independent task. The pivotal position of staff occupying the post of network management and the ways in which the various profiles interact to ensure optimal use of the system should be stressed.

In all countries, regardless of the diversity of the names and the degree of recognition of qualifications and competences which have emerged with the development of networks, there is a more or less formal recognition of the tasks of network manager (administrator or manager) and network maintenance (technician, operator or assistant) which are regarded as principle tasks. But there is not always a clear distinction between tasks. Trends in these tasks correspond with developments in the company (its size, its method of organization, the importance of relations to the external world) and in the area of automization as well as depending on the importance of the activity which the network serves. The member of staff responsible for a particular task can delegate certain activities to other operators or a number of staff may share tasks or be co-responsible for a particular task. Likewise a member of staff may carry out a number of tasks belonging to different job profiles. For example, in Spain doubts were expressed over the capabilities of one person to look after a network in addition to his or her main activity. Tasks linked to networking can be integrated in the job profiles of members of staff who have not a priori direct contact with the network but who still execute these tasks. The criterion which can be used as a reference is salary on account of the lack of network specialists.

Generally, tasks are related to the strategic importance of the network. Executing such tasks presumes trained staff who are adapted and have experience with particular equipment. **Planning** takes place within the company or is subcontracted with the exception of activities requiring no particular skills or they may be partly subcontracted. **Installation** is usually subcontracted and cabling always subcontracted.

Generally, the management function which is vital for the efficient operation of the network remains within the company even though the degree of centralization may vary. **Assistance and maintenance** responsibility is in some cases within the company with sporadic help from outside. Globally there is an increasing trend in large companies to make use of external services under contract for maintaining equipment and system software.

In small companies using computers, either there is a computer scientist to respond to needs or staff has skills and sufficient training and can adapt progressively without the job profiles being defined. In large companies specialized services, which in some cases are of major importance, exist.

REQUIRED COMPETENCES/CAPABILITIES FOR THE JOB PROFILES LISTED

The skills required of each individual working on computer networks apart from those linked to the development of the individual, are acquired through learning and work experience.

They are based therefore on:

- initial training in computer science at the level of advanced secondary vocational school or equivalent or less advanced training supplemented by in-depth work experience and adequate continuing training;
- good computer science knowledge, knowledge of computer and software systems, knowledge of and skills in existing computer systems and related issues;
- an interest in specific areas;
- logical thinking;
- an analytical approach to systems;
- a capacity for conceptual and logical thinking;
- the ability to jump quickly from one train of thought to another;
- an ability to thinks in terms of solving problems and to act accordingly;
- good personal appearance;
- social and communication skills;
- the ability to adapt;
- educational skills;
- ability to collaborate with others, to work in a team and to negotiate;
- flexibility, creativity, inventiveness;
- the desire to take the initiative;
- to work in a result-oriented manner and to forecast;
- perseverance;
- ability to work autonomously, to plan, forecast, organize, coordinate;

- the desire to keep abreast of trends in the field;
- an interest in and affinity with the work;
- high motivation.

Network operations demand specific skills from a variety of profiles and these skills vary in line with the tasks or the level of responsibility assumed. The qualifications and skills cited combine in different ways in the various profiles. Successful practice requires an interdisciplinary and interdependent group effort.

CONCLUSIONS

* Developments in computer occupations

While at the outset computers were a specialist tool, within a period of ten years they became more widespread and accessible to larger numbers. While at the outset every user required basic computer knowledge, this is no longer the case today, with the spread of computers users' understanding has improved and knowledge is shared in a better manner. The scope of computer scientists' tasks has extended and today the computer scientist is more an individual concerned with communication than with technical aspects. Over recent years there has alternatively arisen a need for specialists and generalists as tasks have evolved in this area of activity.

* New activities, new occupations?

Current global trends in computer occupations are marked by a transition from technical mastery to mastering the services to be provided. With the emergence of networks and given the trends which in theory can be foreseen, it is important to pose questions concerning the longevity of related "new occupations" and changes in job content over the coming years. In general we are witnessing an increasing transition of computer tasks towards the user's company and towards even the user within the company. The integration of a system which is becoming more open to the user entails offering more services to the user and also means that an increasing number of people will have access to this knowledge and these skills (that is to say, installing and using a network) so that those individuals employed when networks were born will witness their specific skills becoming more generalized and their work will focus more on coordination and interfacing with the user. The trend is to allow one person to manage a system integrating increasingly diversified tasks and ensuring good service for the user. This does not run contrary to developing specific skills in view of changes in the computer and telecommunications sectors which still

remain two extremely complex areas. One can take the example of the telephone as mentioned by one of the interview partners at the meeting in Brussels. Everyone uses this today without being a specialist while knowing nothing about how it works. He is aware he has his own line, yet highly skilled specialists are required in order to ensure that the overall service operates efficiently.

The French report concluded by saying: "The emergence of local networks requires processes of occupational specialization. Many job descriptions also contain the reference to network. Can a new occupational path be identified? Those interviewed speak of network occupations attained particularly through work experience. These occupations do not emerge in line with local networks but at the moment when complex network architectures are designed or when access is needed to external databases."

* The labour market and computer networks

Although job offers in computing are becoming less frequent and are dropping below the levels of the '80s in certain countries, the offer differs from sector to sector. According to computer experts, systems and networks should continue to expand in the coming years and as in other sectors, sales staff should remain in high demand. The sector is one of the most dynamic in the European economy.

On the basis of the studies, two major employment trends are visible: either a staff member is promoted and someone else assumes his/her former duties, in this case one speaks of creating a new post, or promotion of the individual results in overall changes. A work profile which is clearly defined for the individuals concerned in the company makes it easier for them to accept the changes and to adapt more easily. In other words, involving and motivating individuals is a lengthy task, it depends on the attitude of the managers in the company and is a state of mind. Currently **external recruitment corresponds** increasingly to the needs of the users having large open networks **particularly to the needs of the computer service agencies** (SSIIs). Without any indication of increase in such agencies in the past decade, they are at the top of the scale as far as economic activity in the sector is concerned, ahead of manufacturers and software developers in terms of turnover. The reduction in employment figures in the SSIIs signifies a migration towards companies using computers or towards unemployment.

* The need for interfaces and for high-quality specialists.

There is an undisputed need for an interface between the companies/suppliers, users/service agencies particularly in the SMEs, but also between users who have no specialist knowledge of computers and networks. One hindrance to the development of networks in SMEs is the lack of confidence placed in sales staff and consultants from SSIIs. Generally, SMEs are not equipped with networks on account of the fear of providing access to data and of having to invest beyond their needs. SMEs are not yet convinced that networks can be of added value. This being the case, whereas to date installation was entrusted to suppliers, the situation is changing. However, one question remains: should one assume that a network is useful to every company? The question is a fundamental one which should be examined before installing a network.

* Initial training: learning to learn - continuing training: adapt the system to trends

There is a gap between company needs and what many training organizations offer in relation to training needs and skills. In the majority of countries teachers work with outdated material in view of technological trends and thus cannot respond to the needs of those undergoing training. In this context, the rapporteurs are unanimous in stating that in initial training it is essential that the students learn to reflect and that they continue to learn throughout working life; flexibility and mobility are two essential features. Initial training should follow developments relating to trends in and the integration of computer technology and it should be as comprehensive as possible. Continuing training aims to equip staff with the capability of adapting the system to trends. It tends to capitalize on the individual's curiosity and to emphasize methodology, techniques and a multi-disciplinary approach. The general environment is a fundamental aspect of the job profile of the network computer scientist. Integrating computer science in the most diverse basic training programmes is the next stage to be approached. Currently individuals should construct their own careers. There seems to be no particular career in networking.

The training issue is a delicate one. Are there too many or too few computer scientists? Are they "badly trained"? Does the vast array of training result in a loss of quality? Computer science is a relatively young science. Are we entering the industrialization phase of the computerization process? Employers, in order to recruit, and training centres in order to prepare for recruitment of trainees, endeavour to set up a recognized training course called into being by manufacturers or distributors. Today there seems to be a need to formulate training criteria or to classify existing

criteria which corresponds to the needs of the companies and which allows training centres to avoid becoming dependent on specific products, thus making the profession much more general. A number of training organizations have also launched upon an autonomous approach and are helping to draw up these criteria.

Networks offer real means of communication and new opportunities for users. Naturally the increase in the number of users does not exclude the need for specialists within large companies. On the contrary, the increase in the number of specialists matches the increase in the number of users. It would seem that the pace of technological change requires the services of highly skilled and highly experienced staff to manage efficiently the network resources acquired by the company.